9K33M2 OSA-AK
(SA-8B Gecko)
Short-Range Mobile Surface to Air Missile System
Simulator Documentation



Version: 1

Contents

Preface



The 9K33 OSA (Osa was a river in Latvia) first air transportable (by An-12 or larger), dual service (ground and naval forces), amphibious SAM system development was concluded by NII-20 under the leadership of V.P. Efremov.
It was fully NBC (Nuclear Biological Chemical) protected by filtered over-pressurization system, and was capable of target acquisition while moving and engaging on short stops. It was also the first Soviet SAM system that used transistor-based electrical circuits.
The Soviet Union fielded the first version (OSA) in 1971 for the ground forces, and (OSA-M) in 1973 for the naval forces.
The OSA was constantly improved during its lifetime, resulting in the OSA-AK, and OSA-AKM variants for the ground forces, and the OSA-MA and OSA-MA2 versions for the naval forces. It was widely exported into Warsaw Treaty, and other friendly countries, including the NATO-member Greece.

Hungary never fielded this system.

This program simulates the 9K33M2 OSA-AK (SA-8B Gecko).

Requirement to run this program

Your computer must be able to display a resolution of 1280x1024 or above.



History

The SAM air defense of the Soviet Ground Forces was based on a multi layered organization.

Front and Army level assets were protected by the **medium range 2K11 KRUG** [circle] (SA-4 Ganef) brigade.
While the **Tank Divisions** fielded the more expensive **short range 2K12 KUB** [box] (SA-6 Gainful) regiment, **Motorized Divisions** were planned to be fitted with the cheap autonomous and amphibious **short range ELLIPSE** (SA-8 Gecko) regiment.

Due to serious delays during development, it turned out to be the "black sheep" of the Soviet SAM designs. While general availability was delayed, Warsaw Pact and friendly nations had to field the more expensive 2K12 KUB (SA-6 Gainful) regiments to protect their motorized divisions, causing extra economic burden.

Development Goals - Requirements



The 9th of February 1959 decree № 138-61 of the Central Committee & the Council of Ministers of the Soviet Union ordered the start of the development of the ELLIPSE system, capable of killing supersonic (Mach1) targets out to 8km range flying at altitude between 50m-5000m, on the move and on ships.
Work was started in the NII-20 design bureau, under the leadership of MM Kosichkin, who had extensive experience in the development of small-sized mobile artillery radar systems.

State Trials

In July 1967, at the Emba firing range, the ELLIPSE system was rejected by the state commission on the grounds of...



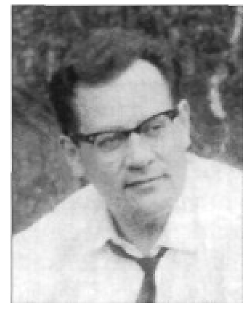
- unable to shoot full 360 degree azimuth

- unable to effectively kill targets below 100m

- unable to engage suddenly appearing targets

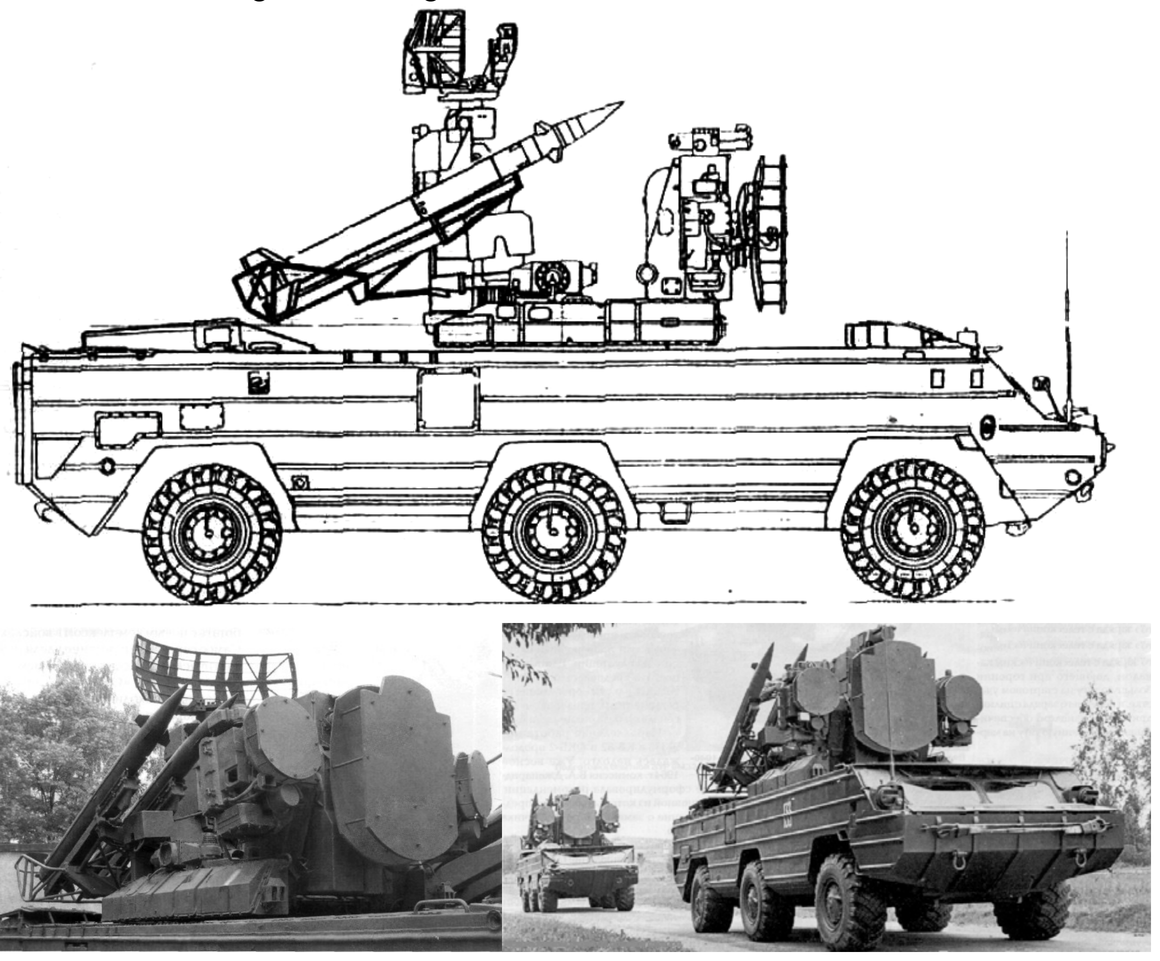
- buoyancy of the vehicle was insufficient

9K33 OSA (SA-8A Gecko)



After the failed state trial MM Kosichkin was replaced, as V.P. Efremov was appointed to lead NII-20. He proposed to delete the requirement of shooting on the move however, suggested to keep the ability of detecting targets during march, and offered a second missile channel.
After a heated discussion of his proposals and despite several protests during the meeting, Chief Marshal of Artillery PN Kuleshov agreed to the design changes.

The base vehicle (Object 1040) was replaced with the BAZ-5937, to increase buoyancy. To reduce its weight and increase its azimuth coverage, the separate launcher and radar towers were rearranged into a single unit.

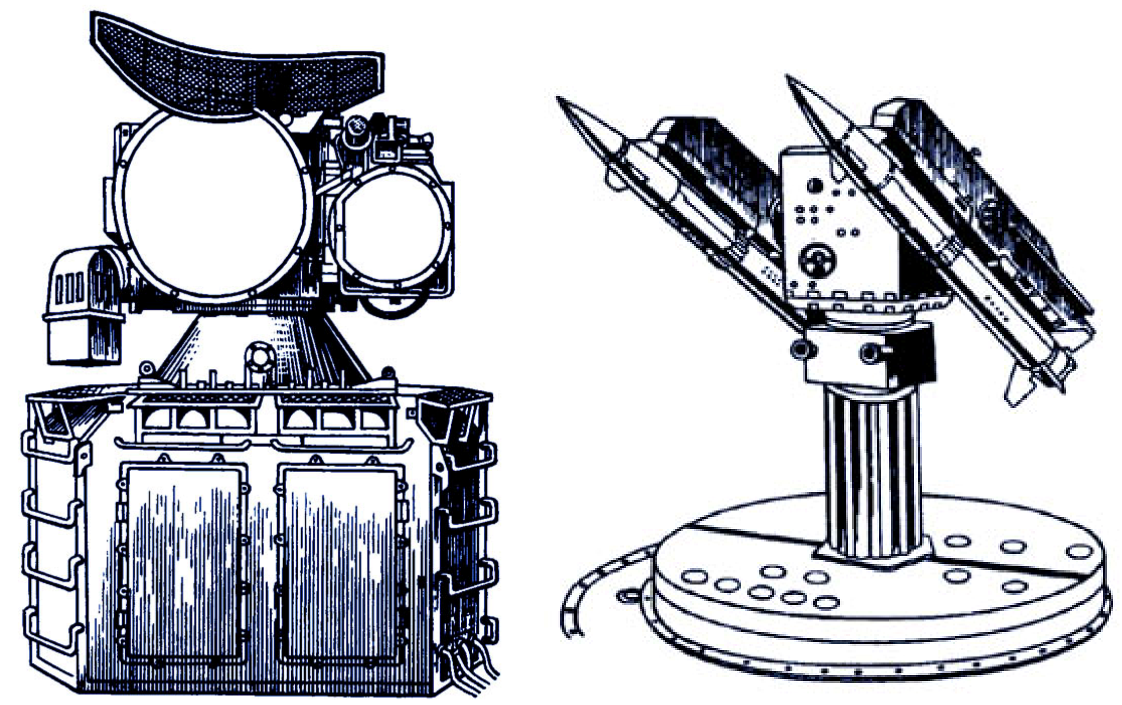


After the successful state trials in October 4th 1971, 9K33 OSA (SA-8A Gecko) was adopted, with the capability of killing a single target with two 9M33M missiles. Production: In ’70-1, ’71-3, ’72-15. In ’73 the 1st regiment was formed with 12 vehicles.

- Target 300m/s (Mach1); 50..5000m altitude, Osa 9km range
- Target 420m/s (Mach1.4); 200..5000m altitude, Osa 7km range

9K33M OSA-M (SA-N-4 Gecko)

The first naval version was accepted into service in 1973.

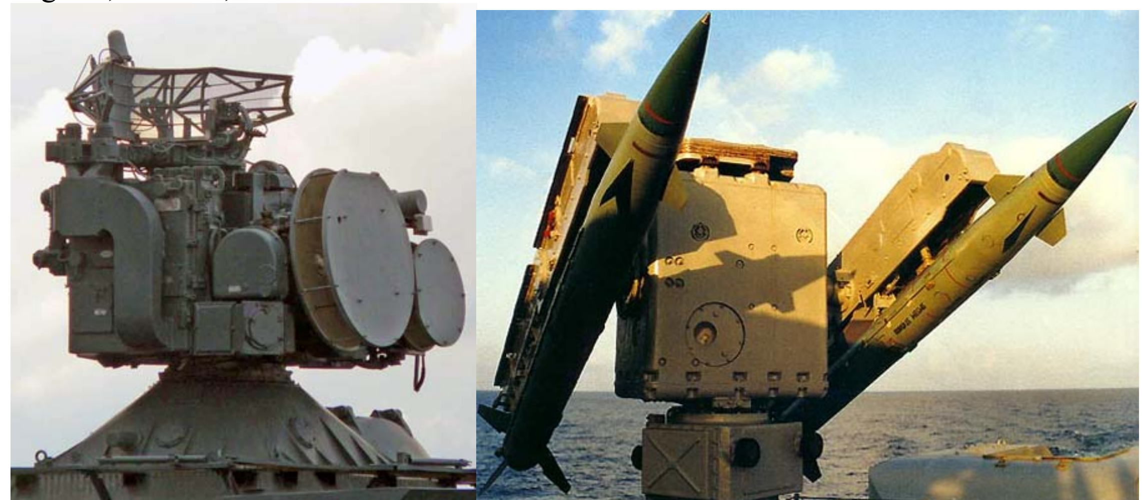


It kept the separated radar-launcher design, the single missile channel, and the capability of shooting "on the move" (ships are never stable on the sea).

The under-the-deck retractable ZIF-122 dual launcher could reload within 16~21s from the four rotatable inside magazines, each holding 5 missiles (altogether 20 rounds).

The system had 70% commonality with the ground based OSA, and used the completely identical 9M33M missile.

It was widely fielded on different class ships: landing ships; hovercraft; corvettes; frigates; cruisers; battle cruisers and aircraft carriers.

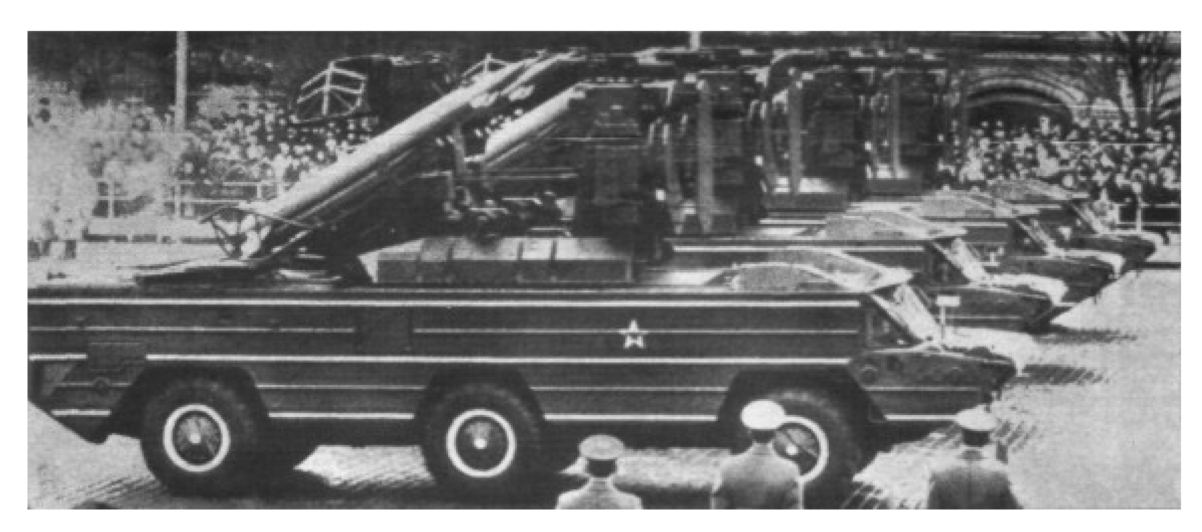


OSA-A

Right after the fielding, the modernization of the complex begun, with the requirements:

- Improving side visibility of the drivers*.
- Capability of killing targets with 500m/s (Mach1.6) speed
- Capability of killing retreating targets up to 300m/s (Mach1).
- Improving the missile overload capability to 25g.

*One of the first improvements of the OSA system appeared during the process of preparing for the first show, at the parade on the Red Square in Moscow on the 7th of November 1975. Training for this event showed that drivers could hardly keep the vehicles aligned for the parade. Soon the left and right side-view windows appeared.





OSA-K



During one of his factory visits, DF Ustinov (Minister of Defense of the Soviet Union) checked the Izhevsk Electromechanical Plant, where the mass production of the OSA system was under way.

After the visit, he told to Chief designer Efremov…

*"Veniamin Pavlovich, you armed this system with only four missiles. We need twice of that!"**

**One of the lessons learned from the ongoing War of Attrition (between Egypt and Israel), was that Soviet SAM systems badly needed to increase the number of ready-to-launch missiles.*

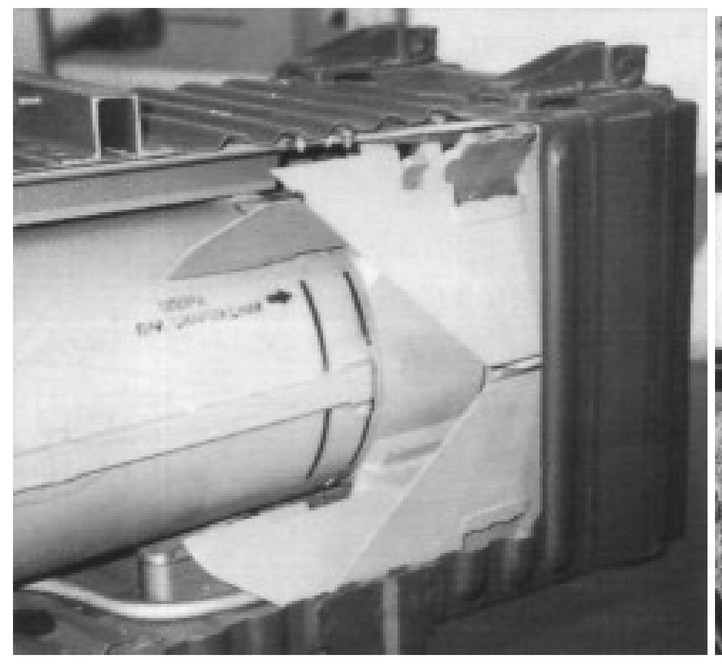
The Chief Designer objected *"Its impossible, due to lack of extra load bearing capability, and buoyancy of the BAZ base vehicle"*

Minister of Defense of the Soviet Union replied, *"This is your concern, report on the execution!"*

After through investigation of the request, Efremov called back the Minister… *"We have worked on your instructions about the possibility of installing eight missiles on the vehicle, eight did not work, but we could place six rockets in canisters."*

Dmitri thought for a moment and said: *"As in the Russian proverb: a* ***black sheep*** *though tuft of wool."*

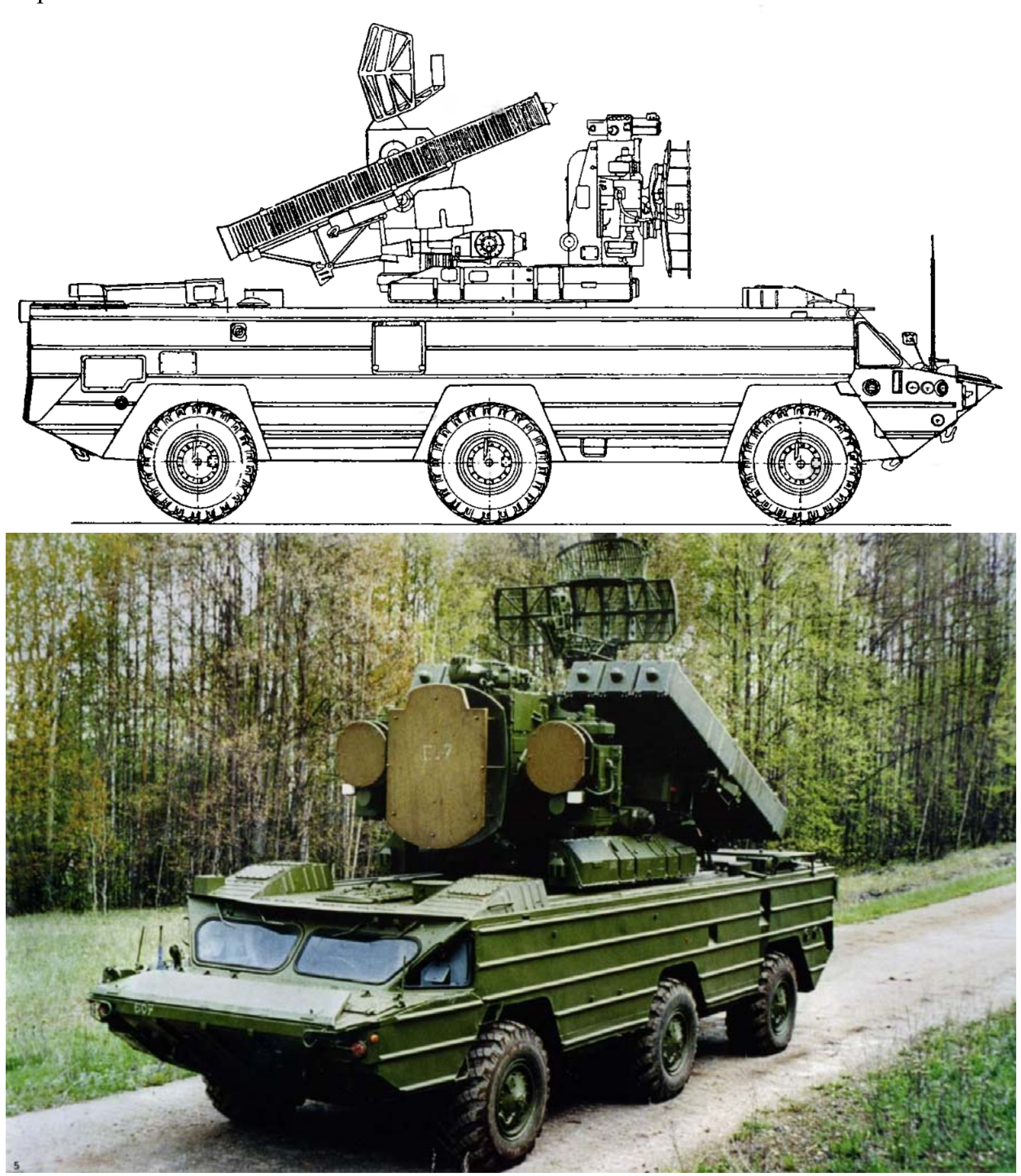
In October 1973, the two parallel modernization programs, the OSA-A and OSA-K, were merged to create the new system 9K33M2 OSA-AK.





9K33M2 OSA-AK (SA-8B Gecko)

After the successful state trials at the second half of ‘74, it was fielded in February 1975. Export started from 1980.



The six containerized missiles **9M33M2** had 5 year shelf life, folded wings, increased overload of 25g, and reduced minimum altitude capability due to a new radio proximity fuse. (Changes in **Bold**)

Target 300m/s (Mach1);	**25**..5000m altitude,	Osa **10**km range
Target **500**m/s (Mach**1.6**);	**100**..5000m altitude,	Osa **10**km range

Export

As export was delayed by **6 years**, most of the WarPact countries had to field the more expensive 2K12 KUB instead of the OSA. According to the original plan of 1959, only the tank division level SAM regiments (only a quarter of all units) were planned to be armed with the expensive KUB, and the rest, the motorized divisions with the cheap OSA.

Due to the development delay, the opposite happened, 33 KUB regiments were fielded against 10 OSA regiments.

This extra financial burden contributed to wrecking the economies of Eastern Europe.

Those KUB regiments that were originally planned to be equipped with the cheap OSA are marked with **RED**.

German Democratic Republic

KUB; **5 regiments, 22 battery**

'76-'83 FRR-8 Schwerin (8.MSD), **4 battery**

'77 FRR-9 Eggesin (9.PD), **5 battery**

'78 FRR-4 Erfurt (4.MSD), **4 battery**

'79-'87 FRR-11 Weißenfels (11.MSD), **4 battery**

'80 FRR-1 Brück (1.MSD), **4 battery**

'83 FRR-7 Zeithain (7.PD), **5 battery**

('87- **4 reserve battery**)

OSA; **2 regiments, 10 battery**

'84 FRR-8 Schwerin (8.MSD), **5 battery**

'87 FRR-11 Weißenfels (11.MSD), **5 battery**

Czechoslovakia

KUB; 7 regiments, 35 battery

'75 171.plp Rožmitál pod Třemšínem (1.A), **3 battery**

'77 +**2 battery**

'75 251.plp Kroměříž (2.A), **3 battery**

'77 +**2 battery**

'78 12.plp Mariánské Lázně (20.MSD), **3 battery**,

'80 +**2 battery**

'79 11.plp Stříbro (19.MSD), **5 battery**

'80 2.plp Janovice nad Úhlavou (2.MSD), **5 battery**

'83 4. plp Jihlava (4.TD), **5 battery**

'85 9. plp Strakonice (9.TD), **5 battery**

OSA; **1 regiment, 5 battery**

'84 5.plp Žatec (1.TD), **5 battery**

Hungary

KUB; 3 regiments, 11 battery

'75-'81 7.lérak.e. Keszthely (5.HDS), **5 battery**

'77 14.lérak.e. Győr (11.hk.ho), **3 battery**,

'81 +**1 battery**

'79 18.lérak.e. Nagykanizsa (8.gl.ho.), **3 battery**,

'81 +**1 battery**

'81 15.lérak.e. Kalocsa (9.gl.ho), **3 battery**

Osa was never fielded

Poland

KUB; **7 regiments, 31 battery**
'74 75pplot Rogowo (20.DP), **4 battery**
'74 66pplot Boleslawiec (11.DP), **4 battery**
'77 55pplot Szczecin Podjuchy (16.DP), **4 battery**
'77 18pplot Jelenia Gora (10.DP), **4 battery**
'80 15pplot Gołdap, **5 battery**
'80 69pplot Leszno, **5 battery**
'86 13pplot Elblag, **5 battery**

OSA; **4 regiments, 16 battery**
'80 83 pplot Koszalin (8.DZ), **4 battery**
'83 128 pplot Czerwińsk (4.DZ), **4 battery**
'84 124 pplot Szczecin (12.DZ), **4 battery**
'87 5 pplot Gubin (5.DP), **4 battery**

Bulgaria

KUB; **2 regiments, 8 battery**
'75 97vdsrp Nova Zagora (2.MSD), **4 battery**
'82 77vdsrp Dimitrovgrad (17.MSD), **4 battery**

OSA; **2 regiments, 6 battery**
'82 50zap Boyanovo (7.MSD),**3 battery**
'88 49zap Blagoevgrad (3.MSD), **3 battery**

Romania

KUB; **3 regiments, 15 battery**
'78 52ra Bucharest, **5 battery**
'82 51ra Craiova, **5 battery**
'84 53ra Medgidia, **5 battery**

OSA; **1 regiment, 4 battery**
'89 50ra Floresti, **4 battery**

Yugoslavia

KUB; **6 regiments, 24 battery**
'75 149.srp Zagreb-Pleso, **4 battery**
'75 60.srp Zadar-Sepurine, **4 battery**
'76 230.srp Nis, **4 battery**
'78 240.srp Sarajevo-Lukavica, **4 battery**
'82 310.srp Kragujevac-Sumarice, **4 battery**
'82, 311.srp Skopje, **4 battery**

Osa was never fielded

States Friendly to the Soviet Union

Angola, Algeria, India, Iraq, Jordan, Libya, Syria

Greece (NATO member)

Greece bought 38 vehicles altogether, and fielded those under the command of ASDEN defending the Aegen islands close to Turkey.
'93 12pcs ex.East German vehicles,
'98 20pcs & '06 6pcs vehicles from Russia,

OSA; **6 battery**
79 MEAP, Samos
80 MEAP, Kos
88 MEAP, Lemnos
95 MEAP, Rhodes
96 MEAP, Chios
98 MEAP, Lesbos

OSA-MA (SA-N-4 Gecko)

From 1979, the naval version received an upgrade, that made it capable of using the **9M33M2** missiles with its reduced 25m target altitude capability.

9K33M3 OSA-AKM (SA-8B Gecko)

To prepare for the under development AH-64 Apache threat, from 1975 a new development started.



With the new radio proximity fuse, and by flying a steeper path, the **9M33M3** missile is capable killing targets hovering at low level (basically at 0m).

It was fielded after the successful trials from 1980. (Capability changes in **Bold**)

- Target **100m/s (360km/h); 10..25m altitude,** Osa **6.5km range**
- Target 300m/s (Mach1); 25..5000m altitude, Osa 10.3km range
- Target 500m/s (Mach1.6); 100..5000m altitude, Osa 10km range

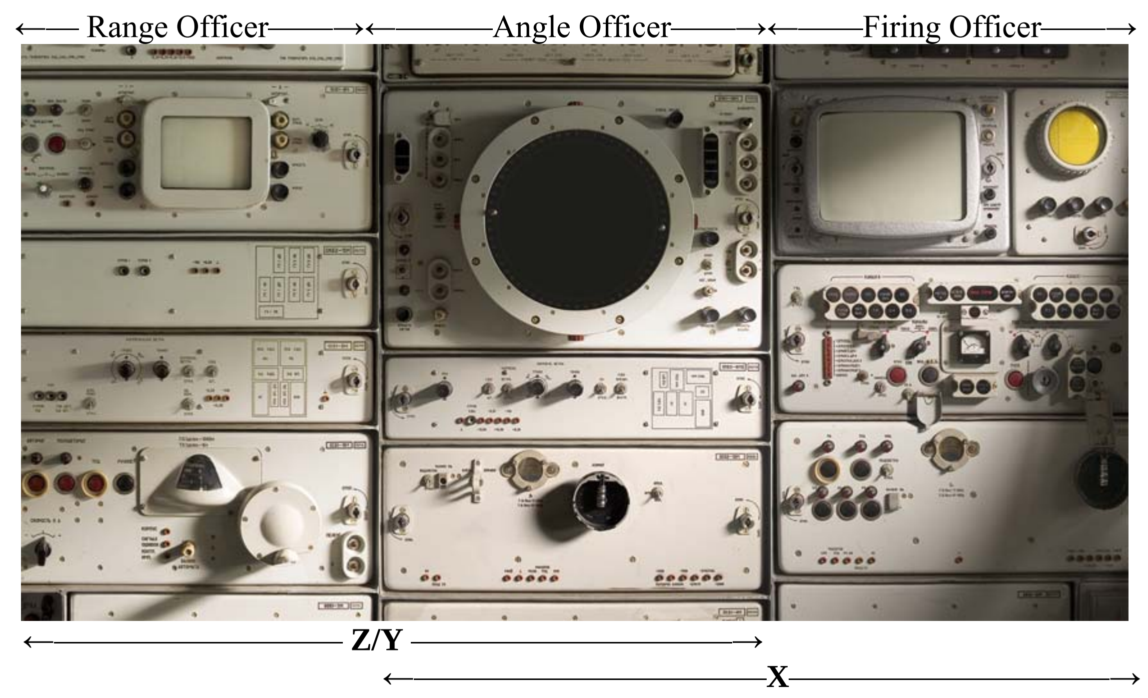
All old 9K33M2 OSA-AK versions were upgraded to this level during the 80's.

OSA-MA-2 (SA-N-4 Gecko)

The naval version again received an upgrade, that made it capable of using the **9M33M3** missiles with their reduced target altitude capability.

Keyboard references for the program

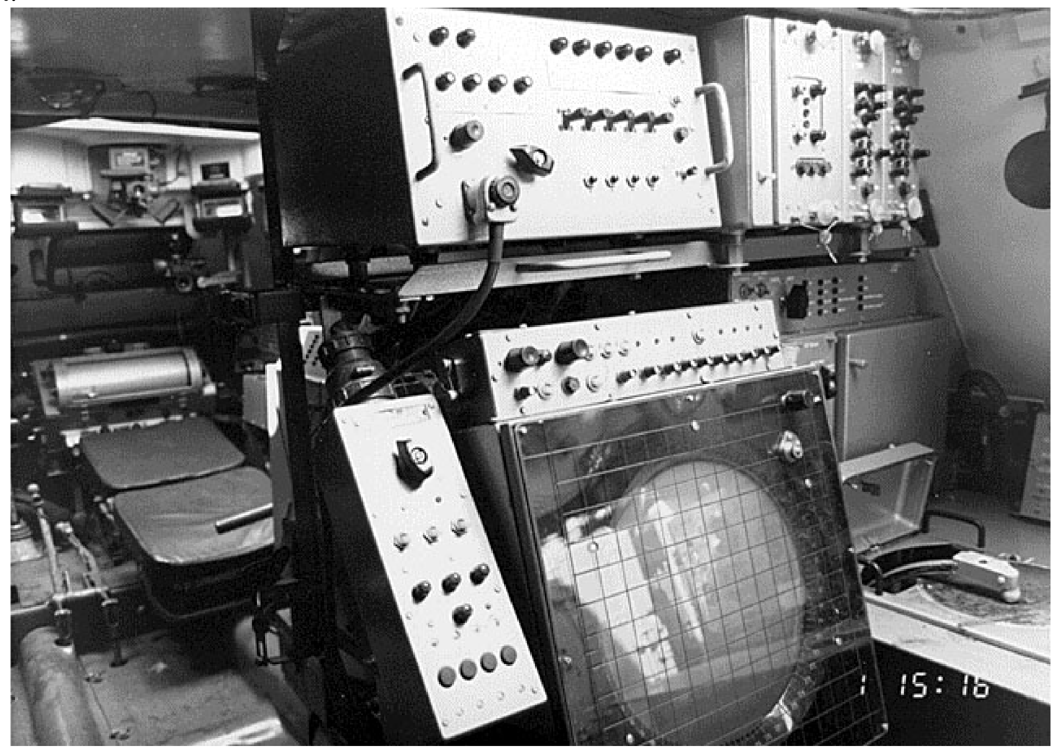
←— Range Officer——→←———Angle Officer——→←——Firing Officer——→



←——————————— Z/Y ———————————→

←————————————X————————————→

Press the **C** key to call up the plotting board of the PU-12 Mobile Air Defense Command Post.



Switching Simulator off

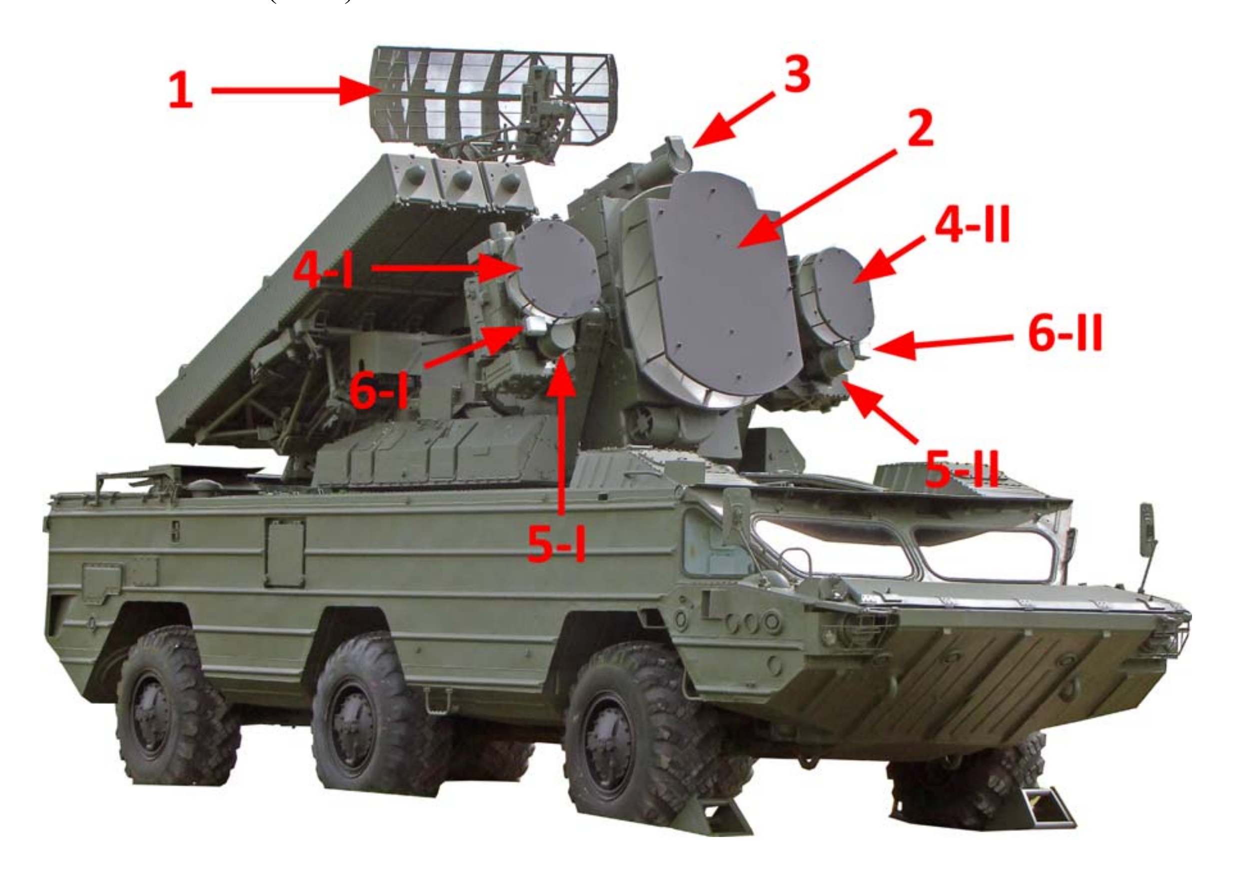
Press the **ESC** key to end the simulation.

Engagement zone

The 9K33M2 OSA-AK has one target and two missile channels, meaning that it can track one target, and guide two missiles onto it. The maximum flight parameters of the target are 500m/s (Mach 1.6) in speed, 10,300m (5,5 nm) in range, and 5km (16,500ft) in height.

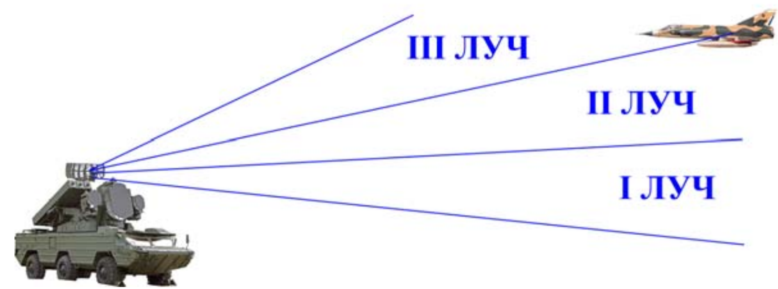
9A33BM2 (Land Roll) Antenna System

It is the most complex mechanically steered target and missiles tracking system designed by the Soviet Union.
The tower can be rotated only ±330° azimuth, similarly to another V.P. Efremov design, the 2K11 KRUG (SA-4).



1. СОЦ, (called "SOC") - Target Acquisition Radar
2. ССЦ, (called "SSC") – Narrow beam Monopulse Target/Missile Tracking Radar
3. ТОВ, (called "TOV") – Target Tracking Camera
4. Medium beam Monopulse Missile Tracking Radar for channels–I/II
5. Conical Scanning Wide beam Missile Tracking Radar for channels–I/II
6. Wide beam Missile Interrogator Radar for channels–I/II

СОЦ (SOC), Target Acquisition Radar

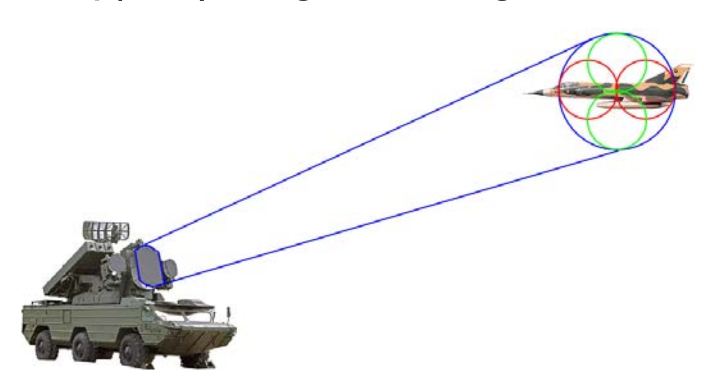


The rotating, 4cm wavelength, 270kW Pulse-Doppler SOC can form three beams (I/II/III ЛУЧ). Maximum displayed range is 45km.



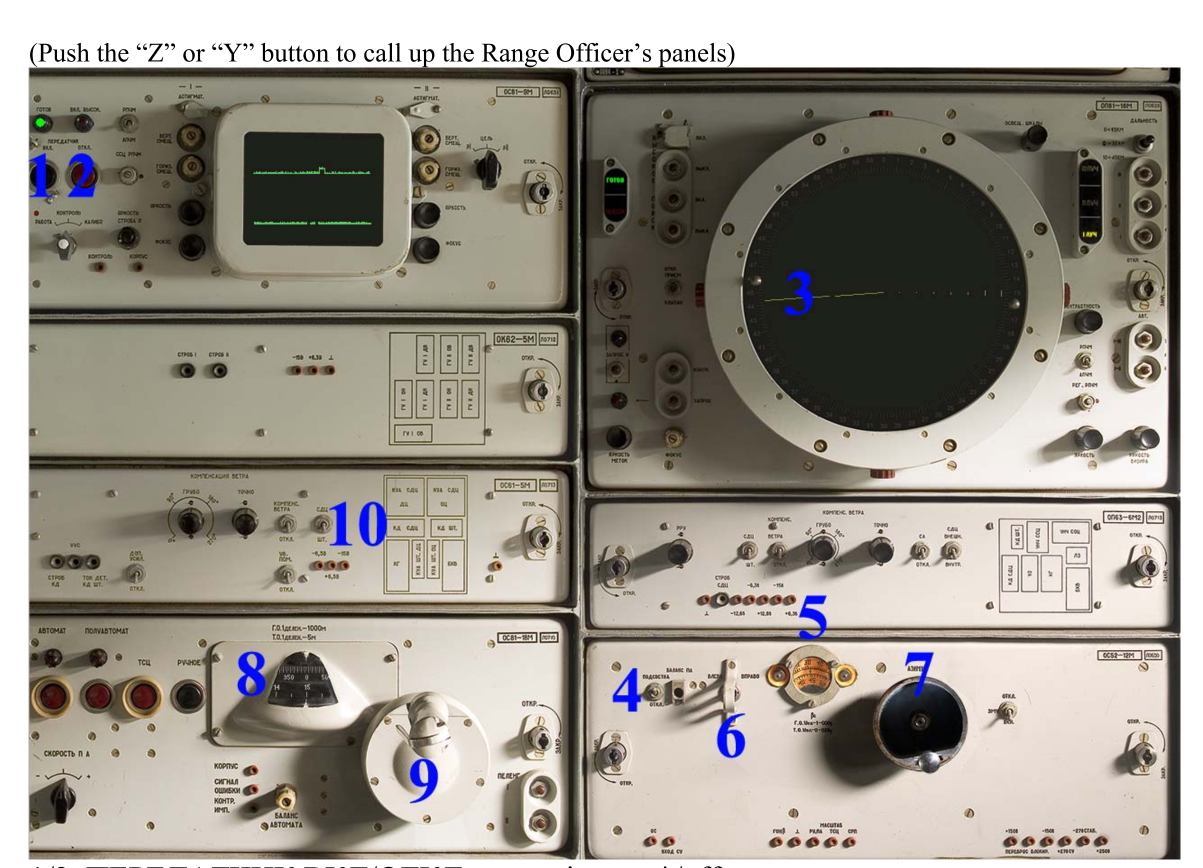
1/2. ПОИСК ВКЛ/ ВЫКЛ, antenna rotation on/off
3/4. ВЫСОКОЕ ВКЛ/ ВЫКЛ, transmitter on*/off
*(click first with the right mouse button to remove the mechanical guard)
5. ДАЛЬНОСТЬ, three position displayed range selector (0-15km, 0-35km, 10-45km)
6/7/8. I/II/III ЛУЧ, scan the lower/medium/upper beam
9. I-III ЛУЧ, sequentially scan all three height beams
10. I-II ЛУЧ, sequentially scan the two lower height beams
11. Ground clutter
12. СДЦ, moving target indicator (only works till 35km in range)

ССЦ (SSC), Target Tracking Radar



The rotatable (±330° azimuth) 2cm wavelength, 180kW Monopulse-Doppler SSC is emitting in the (blue) pencil beam. The reflected signal is received in three beams, (blue, red, green), where two (red, green) beams are double pencils. The target tracking system seeks to minimize the signal across the two double pencils and maximize the signal at the blue pencil beam. Maximum displayed range is 28km.

(Push the “Z” or “Y” button to call up the Range Officer’s panels)



1/2. ПЕРЕДАТЧИК ВКЛ/ОТКЛ, transmitter on*/off
*(click first with the right mouse button to remove the mechanical guard)
3. Azimuth direction of the SSC antenna
4. ПОДСВЕТКА, background illumination of the azimuth indicator instrument
5. βc, azimuth instrument, read in Russian Imperial military angle (60-00 is 360°)
6. ВЛЕВО ВПРАВО, left/right fast rotation of the SSC (press left/right mouse button)
7. АЗИМУТ, left/right slow rotation of the SSC (press mouse button and move it)
8. Range instrument
9. Range wheel (press left/right mouse button and move it fine/coarse)
10. СДЦ, moving target indicator

(Push the “X” button to call up the Fire Officer’s panel)



1. ПОДСВЕТКА, background illumination of the elevation indicator instrument
2. □c, elevation instrument read in Russian Imperial military angle (15-00 is 90°)
3. РУ (called “RU”), manual elevation mode
4. УГОЛ МЕСТА, up/down rotation of the SSC, if the RU mode is selected
(press the left mouse button over the wheel and move it up/down)

9Ш38-2 ТОВ (9Sh38-2 TOV), Target Tracking Camera



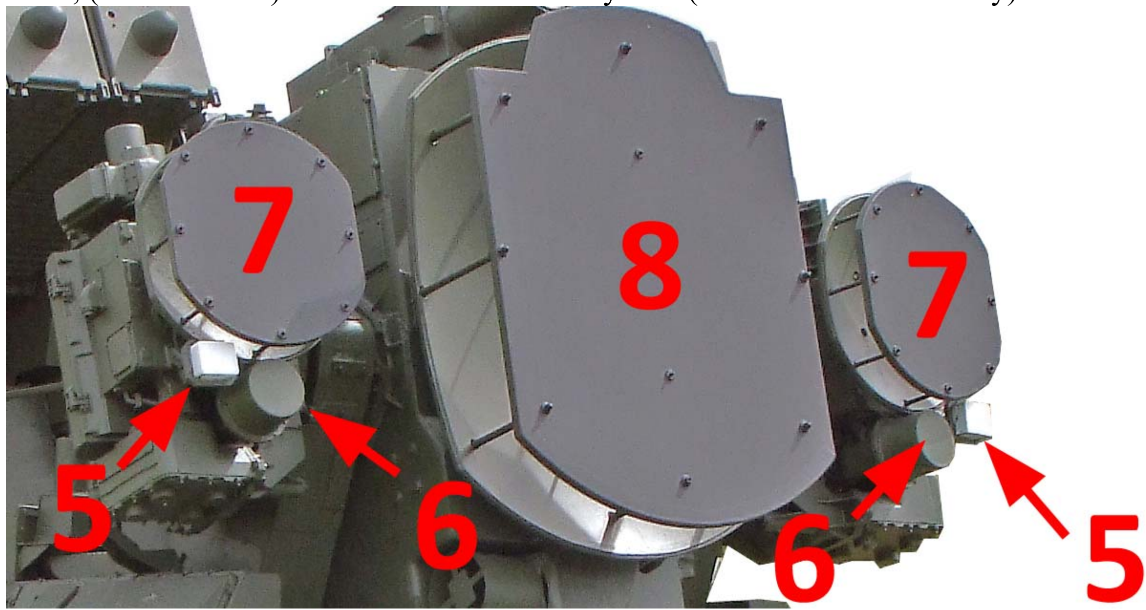
The black and white daylight only, 67kg optical target tracking camera has a wide 5° (F=150mm) and a narrow objective 1.5° (F=500mm).
(Push the “X” button to call up the Firing Officer’s panel)



1. РАБ.РЕЖ. ВКЛ/ВЫКЛ, switch the camera on/off
2. УГОЛ ЗРЕНИЯ ШИРОКИЙ/УЗКИЙ, wide/narrow objective selector

СВР and СПК, the Missile Tracking and Guidance System

СВР, (called “SVR”) – Missile Beacon Tracking System (Receive Only)
СПК, (called “SPK”) – Command Guidance System (100kW - Transmit Only)



(Push the “X” button to call up the Firing Officer’s panel)



1. ГОТОВ СПК, SPK system is ready – not transmitting
2. ВКЛ ВЫС, SPK system is transmitting missile guidance commands.
3. ЗАХВАТ, SVR system ready to receive missile beacon signals.
4. СХОД, Missile launched – left its container
5. SPK is transmitting signals by the Wide beam Missile Interrogator Antenna.
6. SVR receives the missile beacon reply, and tracks it within 0.8s by the Conical Scanning Wide beam Missile Tracking Antenna.
7. СР.Л, missile is tracked (SVR - receive) and guided (SPK - transmit) by the Monopulse Medium beam Missile Guidance Radar.
8. УЗКИЙ ЛУЧ, during missile guidance, its relative position to the target is measured by the Narrow beam Monopulse Target/Missile Tracking Radar (SVR - receive).
In this phase, the guidance commands (K1, K2, K3)* are still transmitted by the Monopulse Medium beam Missile Guidance Radar (7).

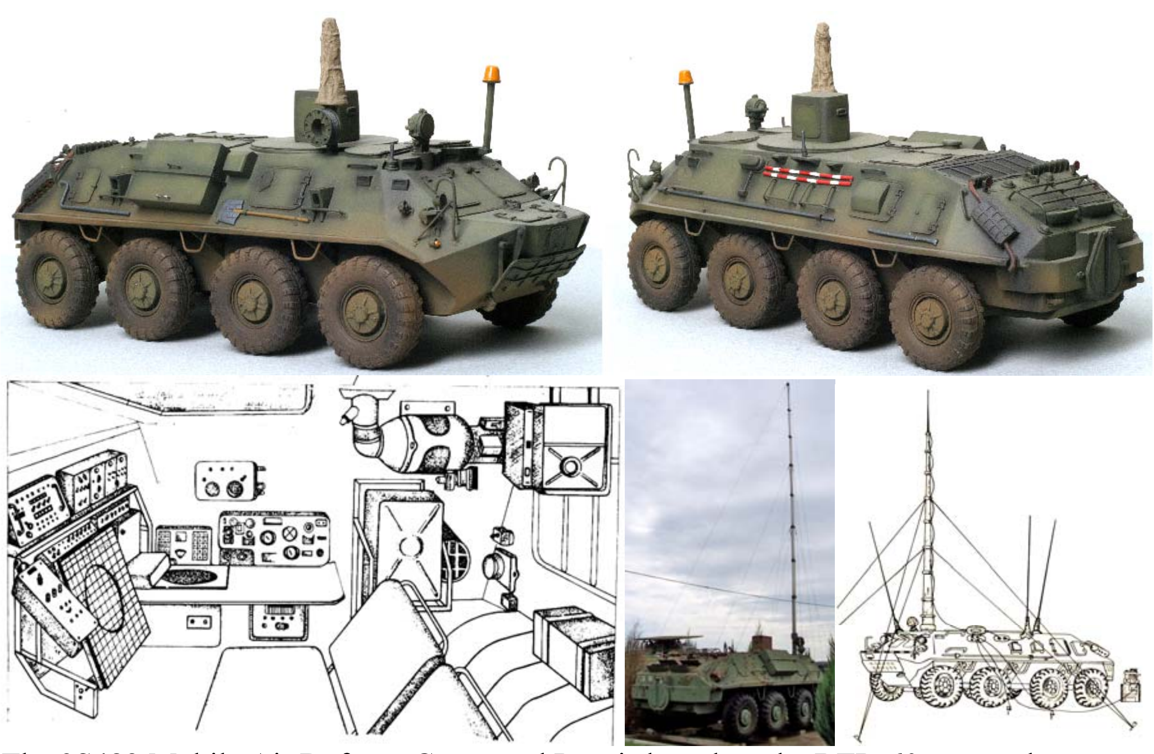
*missile guidance commands
K1, K2 – missile turn
K3 – arm radio proximity fuse

Target acquisition

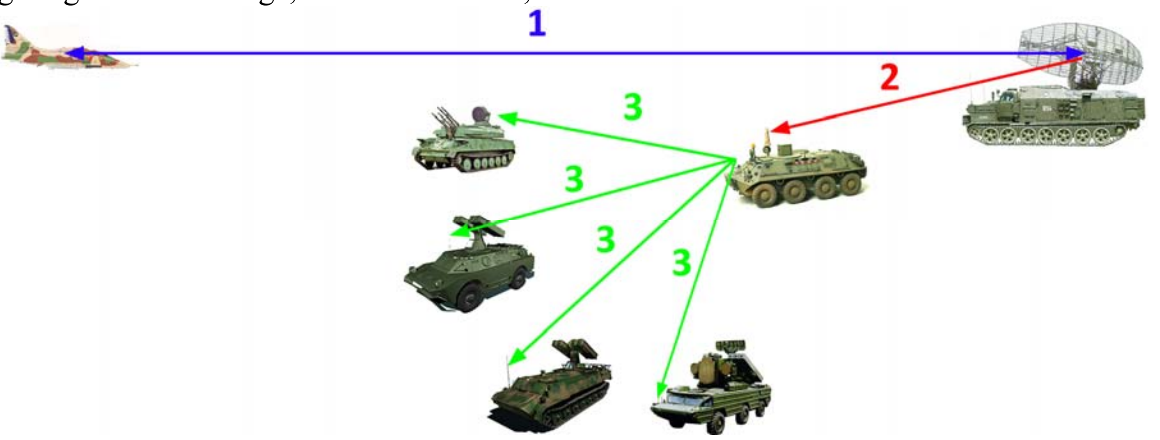
There are two possible methods of target acquisition:

- Target acquisition information received from the 9S482 BTR-60 PU-12 relay.
- Autonomous target acquisition via the onboard SOC radar.

9S482 BTR-60 PU-12 Mobile Air Defense Command Post



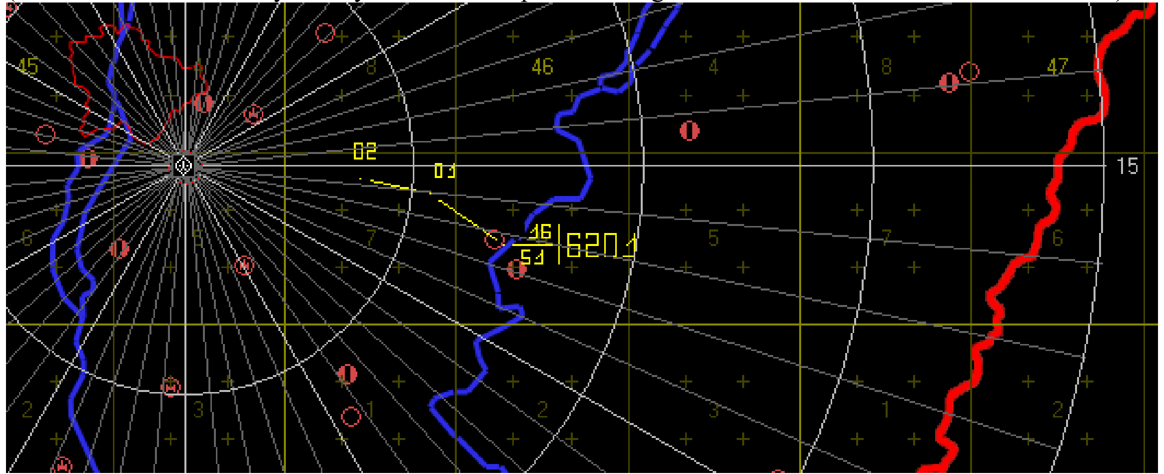
The 9S482 Mobile Air Defense Command Post is based on the BTR-60 armored personnel carrier. The turret was replaced by a telescopic antenna (16m max height) giving 25~30km range, and on the inside, an Air Defense Command station was added.



1. Division-level radio technical troops detect an incoming target.
2. Target coordinates are sent to the 9S482 BTR-60 PU-12 via digital datalink channel
3. Target information is transmitted to the ZSU-23-4V1 Shilka, 9K33 OSA (SA-8 Gecko), 9K31 Strela-1 (SA-9 Gaskin), or 9K35 Strela-10 (SA-13 Gopher) batteries via radio (voice channel).

Plotting Board

(Press the "C" button on your keyboard to call up the Plotting board inside of the 9S482 BTR-60 PU-12)



Target parameters, detected by radar battalions (red circles in the table) are written on the glass plotting board.

Target parameters :

6201 | 16/51

6201 (Tall numbers) – target number

62 – Tactical number of the radar battery, detected the target first

01 – Sequential number of the target, detected by the same radar battery

16 (numerator) – Target height in hectometers (16x100=1,600m)

51 (denominator) – type of the target (friendly – *1 aircraft*)

(tens digit)

0 – jamming target
1 – friendly target
2 – identified target
3 – border violator
4 – supervisor target
5 – own target (friendly return)
6 – rule violator target
7 – practice target
8 – enemy
9 – target without IFF

(ones digit)

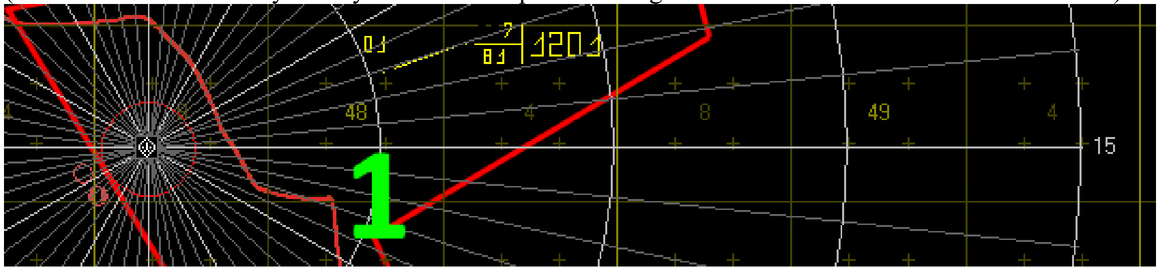
Number of targets in the formation (1 aircraft)

The location of the target is updated every minute, and a timestamp is noted (01, 02, …). White circles are marking the range from the battery (50-100-150-200km).
The target direction can be read from the radial lines in angular mil, (thin line every one, bold line every 5 angular mil). 60-00 angular mil is 360 degree. North: 00-00, East: 15-00, South: 30-00, West: 45-00 *(just use it as the small/minute hand of a clock.)*

Target data read from the plotting board, above: One own plane, direction ***15-50*** *angular mil, range 35km, height 1,600m.*

Automatic target acquisition

(Press the “C” button on your keyboard to call up the Plotting board inside of the 9S482 BTR-60 PU-12)



1. Wait until the target track is approached the 50km (inner white) range circle.

(Push the “Z” or “Y” button to call up the Range Officer’s panels)



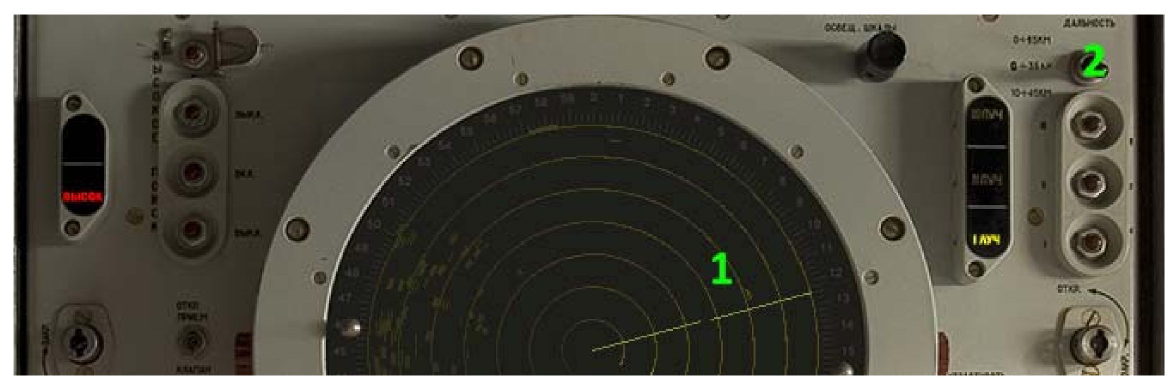
1. ПОИСК ВКЛ, target acquisition (SOC) antenna rotation on
2. ВЫСОКОЕ ВКЛ, transmitter (SOC) on*

*(click first with the right mouse button to remove the mechanical guard)

3. I-III ЛУЧ, sequentially scan all three height beams with the target acquisition radar
4. ДАЛЬНОСТЬ, click to set the displayed range selector to 10-45km (switch - down)
5. When the target echo is visible – select (click) the actual scanning beam (6) shown on the illuminated indicator (7)



1. Unlock the Azimuth wheel, by clicking on it with the right mouse key.
2. ПОДСВЕТКА, click on the background illumination of the azimuth indicator instrument



1. When the target sign approaches the 35km mark, select the 0-35km range setting (2).



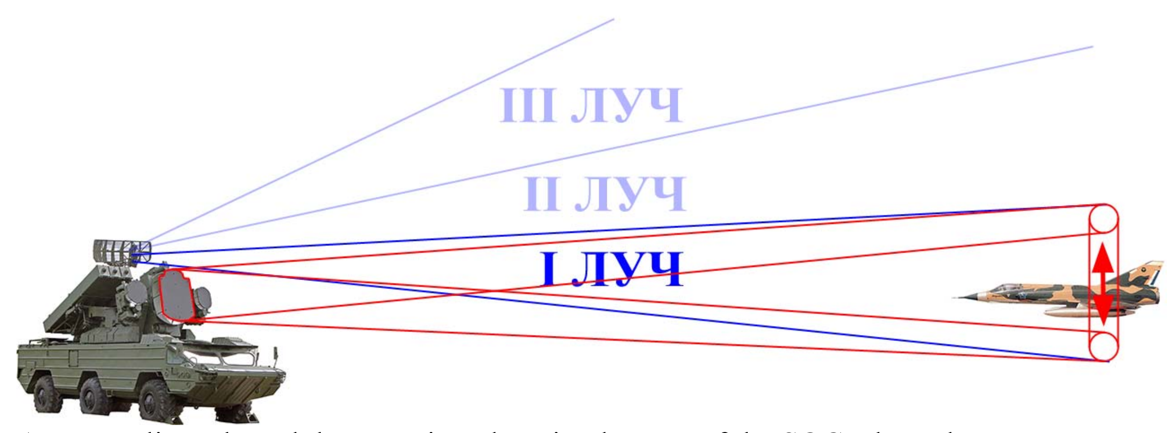
1. Move the range gate (press right mouse button and move it right) to 27.5km



1. Rotate the SSC azimuth line by holding the mouse button over the azimuth wheel (2) and moving it horizontally, until it intersects the target mark (3).



1. Unlock the Elevation wheel, by clicking on it with the right mouse key.
2. ПОДСВЕТКА, click on the background illumination of the elevation indicator instrument
3. ЦУ АЗ, by clicking this button, the “Automatic target acquisition” mode is engaged



As we earlier selected the scanning elevation beam-I of the SOC where the target appeared, the SSC - pencil Narrow beam of Monopulse Target/Missile Tracking Radar will scan only that elevation vertically.

(Push the “Z” or “Y” button to call up the Range Officer’s panels)



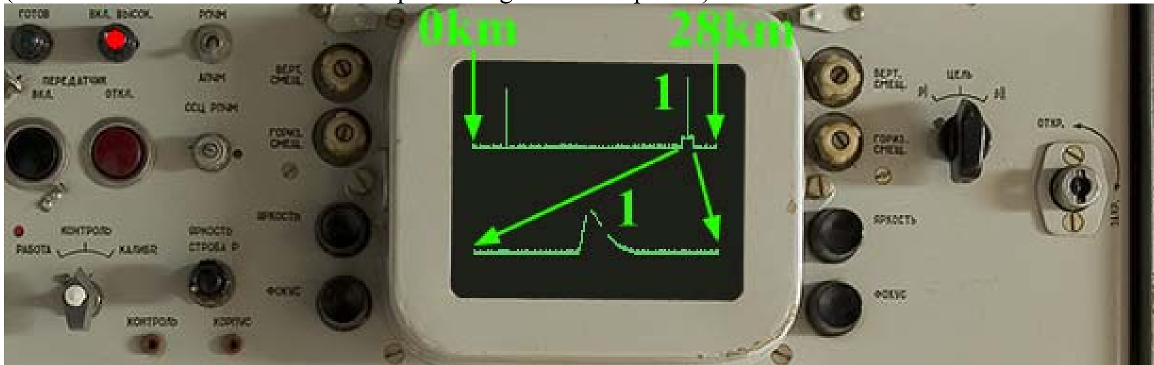
1. When the target approaches the 30km mark…
2. ПЕРЕДАТЧИК ВКЛ, click transmitter of the SSC Monopulse Radar on*
*(click first with the right mouse button to remove the mechanical guard)

(Push the “X” button to call up the Firing Officer’s panel)



1. When the SSC is on the target azimuth, and it is in the range gate, it’s automatically captured.
2. ТСЦ, (called “TSC”), automatic target tracking mode is engaged
3. The target signal is displayed in the elevation indicator

(Push the “Z” or “Y” button to call up the Range Officer’s panels)



The range indicator has two sweeps. Upper sweep shows 28km range (0km at left, 28km at right), and the target (**1**) is indicated as a spike. The lower sweep is a 1.5km magnification of the upper sweep, showing the area within the range gates.



1. ABTOMAT, automatic range tracking lamp is illuminated
2. Range indicator is spinning, showing the actual measured target distance (~27,220m)

Tracking targets flying at ultra low altitude

Due to ground clutter at very low altitude, targets can only be reliably tracked in angles with the built-in camera system (TOV). In Range, the SSC can still reliably track the target.

(Push the "X" button to call up the Firing Officer's panel)



1. НЛЦ, lamp is indicating that the target is flying too low for the SSC
2. РАБ.РЕЖ. ВКЛ, switch the target tracking camera on
3. РУ (called "RU"), manual tracking mode

NOTE: Manual target tracking mode requires increased skill from the operators

Move target under cross hairs on TV screen 6, by moving:
4. АЗИМУТ, left/right slow rotation of the SSC (press mouse button and move it)
5. УГОЛ МЕСТА, up/down rotation of the SSC (press mouse button and move it)
6. when the target is moved into the bore sight crosshair,
7. Initiate angle tracking* with TOV camera system by pressing ПА, (called "PA")
* In the real world, the target is angle tracked manually with the wheels.

Beside angle tracking, we need to know the actual target range…

(Push the “Z” or “Y” button to call up the Range Officer’s panels)

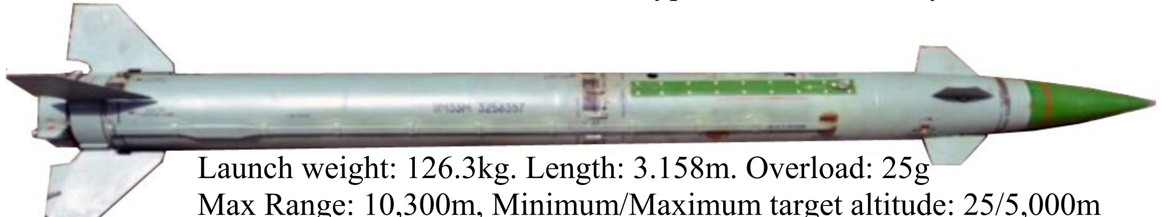


1, You need to acquire the target signal (2) with the range wheel (press left mouse button and move it left/right) into the range gate

3, ПОЛУАВТОМАТ, press button to track target with the SSC in range only

9M33M2 surface to air missile

Fielded from 1975, the first containerized missile type of the OSA family.



Launch weight: 126.3kg. Length: 3.158m. Overload: 25g
Max Range: 10,300m, Minimum/Maximum target altitude: 25/5,000m



9D15 Dual thrust solid fuel engine.
Propellant: 9H15
Weight: 77.5kg
Burn time: 13.2~19.2s (depending on outside temperature)
Max speed: 640m/s (Mach 2)

9E316M Radio proximity fuse receiver



Foldable rotating fin



9B390M autopilot.
Time to spin up gyroscopes before launch: 15s

9N16 warhead.
Weight: 14.27kg
Fragments: 1,580pcs
Fragment Weight: 3.86g

9E316M Radio proximity Fuse transmitter

Steering fins. Capable of pulling 25g

Air pressure bottle for the electrical and steering system.
Pressure: 37MPa
Contents: 2.5 liters of air
Maximum flight time: 24~27s

9T217BM2 TZM missile transporter-loader

The TZM is based on the BAZ-5939 amphibious chassis.
The containerized missiles are loaded with the built-in crane.

Each battery of 4 launchers has 2 TZM vehicles, each carrying 12 missiles.
Altogether 48 missiles per battery. (4x6 on launchers, 2x12 on TZMs)





Preparation for firing

(Push the "X" button to call up the Firing Officer's panel)



1. РОД РАБОТЫ - БР, Select live firing mode (leftmost setting)
2. ЗАПРЕТ ПУСКА, Insert the firing authorization key (use the right mouse key once)
3. Check available missiles 1-II,2-II,3-II for the left launcher 3-I,2-I,1-I for the right one.
4. ДЦ, Monitor measured target distance on the Voltmeter. (10V – 10km)



1. ВНИМАНИЕ, Caution lamp will signal, if the target will approach the firing zone within 15s.
Missile preparation (gyroscope spin up) automatically starts.
2. ЗАХВАТ, SVR system ready to receive missile beacon signals.
3. ВКЛ ВЫС, SPK system is transmitting missile guidance commands to the equivalent antenna.



1. ПУСК ГОТОВ, missile is ready to be launched.
2. ЦЕЛЬ В ЗОНЕ, target is within the firing zone.

Ну Давай! ПУСК!



1. ЗАПРЕТ ПУСКА, Rotate the firing authorization key (use the right mouse key once)
2. ПУСК, click on the launch button. After pushing it, the launch command goes into the automatically selected missile. Its guidance method is also automatically chosen according to the flight parameters of the target. First, pyrotechnic bolts open both covers of the container, then another pyrotechnic device opens the pressurized air valve, this spins up the electrical turbo generator. When electrical power supply reaches the nominal level, the gyroscopes are unlocked.
3. СХОД, Another pyrotechnic charge ignites the solid fuel engine, and the missile leaves the container.



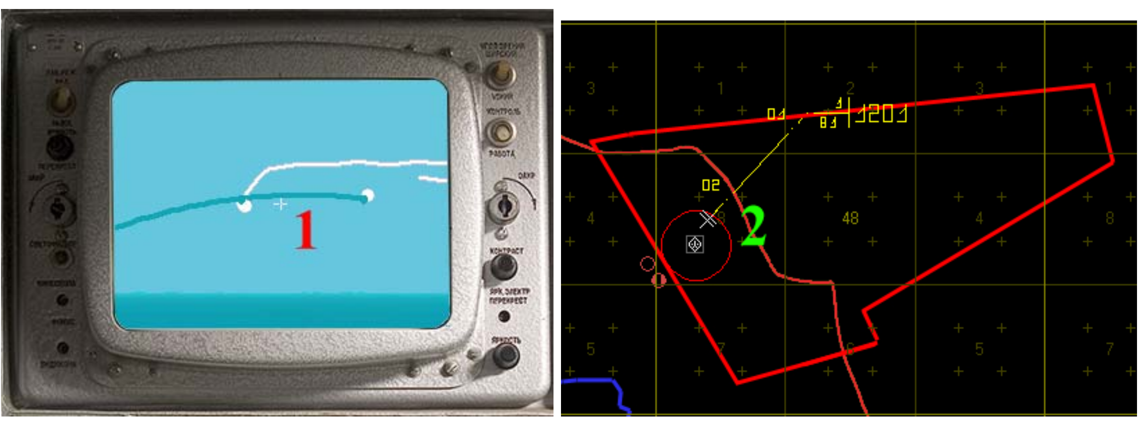
4. ПУСК ГОТОВ, when the missile ready light illuminates again, we can launch our second missile with the ПУСК (2) launch button.



Observing the result of the shooting

Several factors are needed to be observed, to assess the result of shooting.

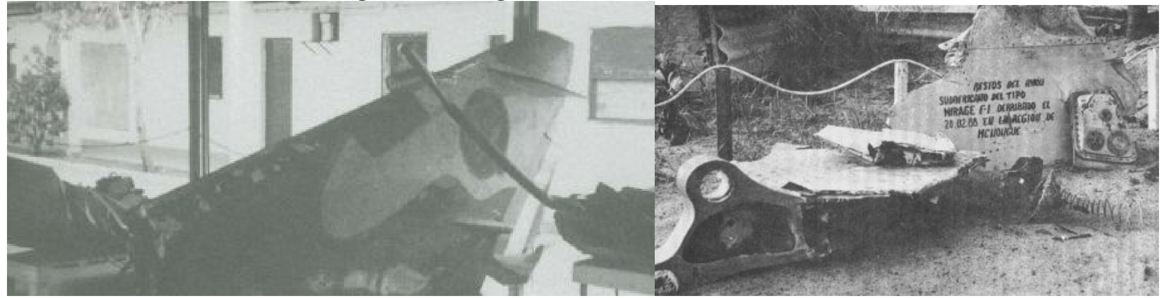




1. On the TOV, the missile warhead detonation is visible, and the target is falling with smoke.
2. The place of explosion is marked at the plotting board by an “X”. After successfully shooting, the flight path of the target ends.



South African Mirage-F1AZ no.245 flown by Maj. Ed Every.
He was shot down over Angola, during the battle of Cuito Cuanavale. 20/02/88



Anti Radiation Missile (ARM)

ARM's, deployed since the 1960s, guide themselves to the microwave energy emitted by radars. As these missiles are visible in the radar screens, like fast approaching targets, the best defense against them is to turn the radar off in time.

Texas Instruments AGM-45 Shrike

The first fielded ARM, had significant limitations.



Fielded: 1963
Speed: 1.5Mach
Maximum Range: 45km
Length: 3.14m
Diameter: 20.3cm
Weight: 176kg
Warhead weight: 53kg

General Dynamics AGM-78 Standard ARM

The second ARM the US fielded, developed from the RIM-66 ship borne SAM. Provided increased speed, range and tactical flexibility.



Fielded: 1968
Speed: 1.8Mach
Maximum Range: 120km
Length: 4.2m
Diameter: 38cm
Weight: 589kg
Warhead weight: 100kg

Raytheon AGM-88 HARM

The state of the art ARM, it replaced the former types.

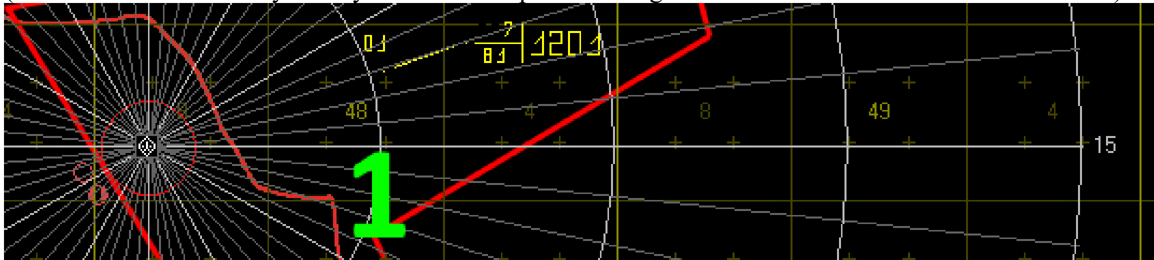


Fielded: 1982
Speed: 2,1Mach
Maximum Range: 150km
Length: 4,2m
Diameter: 25cm
Weight: 363kg
Warhead weight: 65kg

Target Engagement with Emissions Control

As the 9M33M2 missile speed is comparable to the ARM's, limiting our radio electronic exposure to the time period of missile guidance will dramatically increase the battle survivability of the system.

(Press the "C" button on your keyboard to call up the Plotting board inside of the 9S482 BTR-60 PU-12)

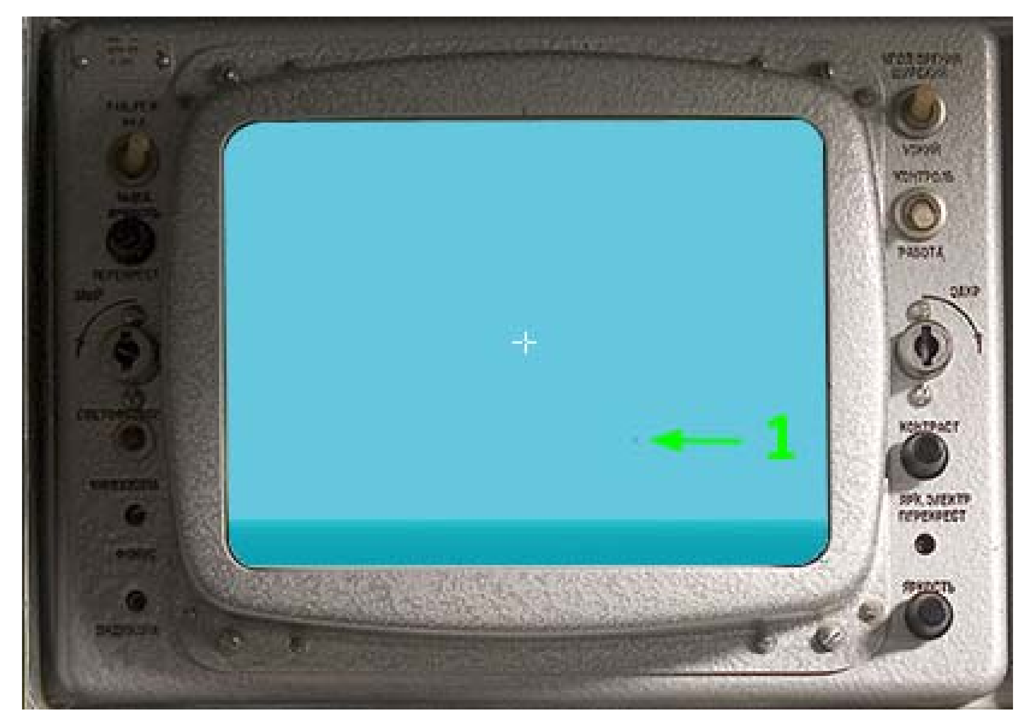


1. Wait until the target track is approached the 50km (inner white) range circle.

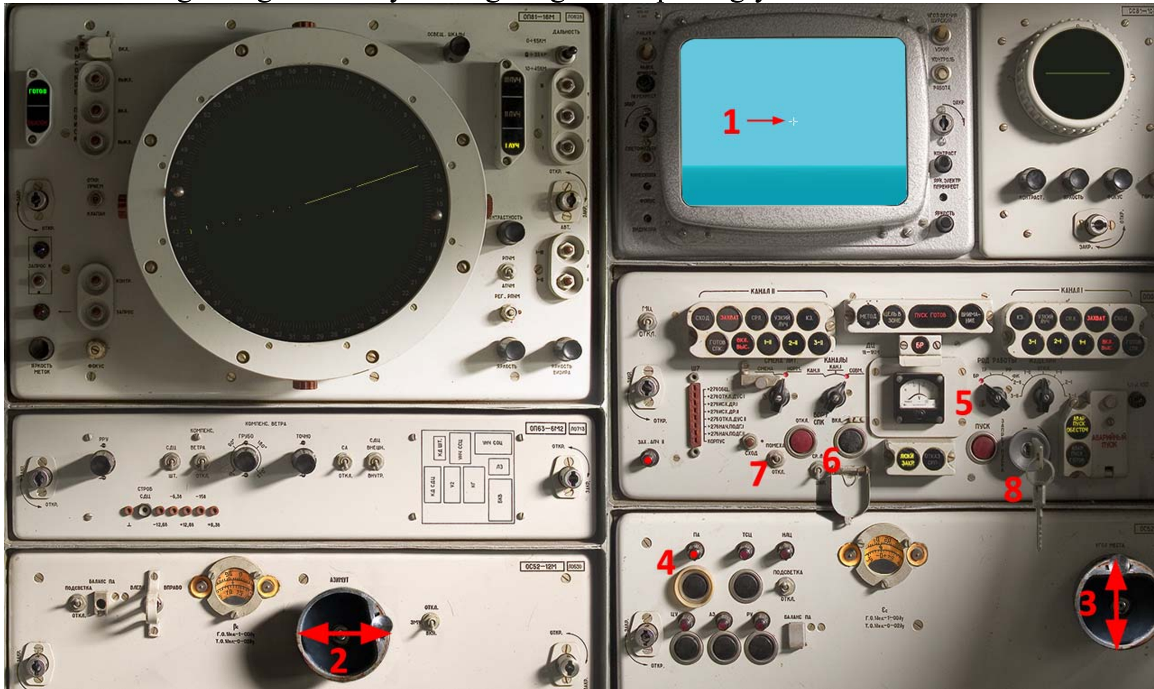
(Push the "X" button to call up the Firing Officer's panel)



1. РАБ.РЕЖ. ВКЛ, switch the target tracking camera on
2. ПОДСВЕТКА, click on the background illumination of the azimuth indicator instrument
3. АЗИМУТ*, left/right rotation of the SSC (press mouse button and move it) towards the Azimuth of the incoming target, detected on the plotting board
*First unlock the Azimuth wheel, by clicking on it with the right mouse key.
4. ПОДСВЕТКА, click on the background illumination of the elevation indicator instrument
5. УГОЛ МЕСТА, up/down rotation of the SSC (press mouse button and move it)
Scan slowly upwards to detect the target on the TV screen.
NOTE: Manual target tracking mode requires increased skill from the operators



1. Discovering a target visually at long range is surprisingly difficult



1. when the target is moved into the bore sight crosshair, using the wheels (2, 3)
4. Initiate angle tracking with TOV camera system by pressing ПА, (called "PA")
5. РОД РАБОТЫ - БР, Select live firing mode (leftmost setting)
6. БОРТ СПК ВКЛ, Missile, SPK, and SVR preparation should be started manually*
*(click first with the right mouse button to remove the mechanical guard)
7. ПОМЕХА, As we do not know the target real distance, we set the radio proximity fuse to arm right after launch (switch selected up)
8. ЗАПРЕТ ПУСКА, Insert the firing authorization key (use the right mouse key once)

1. УГОЛ ЗРЕНИЯ УЗКИЙ, switch down to select narrow objective
2. Assuming an average sized target, when its apparent size grows to fill area within crosshairs, we can assume it is within firing range.
3. ЗАПРЕТ ПУСКА, Rotate the firing authorization key (use the right mouse key once)
4. ПУСК, click on the launch button. After pushing it, the launch command goes into the automatically selected missile. Its guidance method is also automatically chosen according to the flight parameters of the target. First, pyrotechnic bolts open both covers of the container, then another pyrotechnic device opens the pressurized air valve, this spins up the electrical turbo generator. When electrical power supply reaches the nominal level, the gyroscopes are unlocked.
5. СХОД, Another pyrotechnic charge ignites the solid fuel engine, and the missile leaves the container.



6. ПУСК ГОТОВ, when the missile ready light illuminates again, we can launch our second missile with the ПУСК (4) launch button.